CLAIMS

We claim:

1 A method of determining intra-field distortion in a projection imaging tool, the method comprising:

exposing a reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least one array of alignment attributes;

exposing the reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position is shifted in a desired direction by a desired amount, wherein an alignment attribute exposed during the first exposure and an alignment attribute exposed during the second exposure form a completed alignment attribute;

measuring positional offsets of the alignment attributes in the completed alignment attribute; and

determining a lens distortion map from the resulting positional offset.

2. A method as defined in Claim 1, wherein the alignment attributes are wafer alignment marks.

3. A method as defined in Claim 2, wherein measuring of the positional offsets is performed by a lithography tool wafer alignment mark measurement system.

4. A method as defined in Claim 1, wherein the desired direction corresponds to an X direction.

5. A method as defined in Claim 1, wherein the desired direction corresponds to a Y direction.

6. A method as defined in Claim 1 wherein the at least one array of alignment attributes further comprises a first and a second array of alignment attributes wherein the first and second arrays of alignment attributes have features complementary to each other and the arrays have the same pitch and are offset from each other.

7. A method as defined in Claim 6, wherein the reticle pattern in the second position is shifted so that the second exposure of the array of alignment attributes overlay the first exposure of the array of alignment attributes thereby forming a completed alignment attribute.

8. A method as defined in Claim 7, wherein the completed alignment attribute comprises a box in box alignment attribute.

9. A method as defied in Claim 7, wherein the completed alignment attribute comprises a frame in frame alignment attribute.

10. A method as defined in Claim 7, wherein the completed alignment attribute comprises gratings.

11. A method as defined in Claim 7, wherein the completed alignment attribute comprises vernier pairs.

12. A method as defined in Claim 7, wherein the completed alignment attribute comprises Van der Pauw resistors.

13. A method as defined in Claim 7, wherein the completed alignment attributes comprise capacitor structures.

14. A method as defined in Claim 1, wherein the reticle pattern is a curved field.

15. A method as defined in Claim 1, wherein the an x-tilt and a y-tilt Zernike coefficients of the projection imaging system are determined.

16. A method as defined in Claim 15, wherein determining the x-tilt and y-tilt Zernike coefficients further includes determining higher order contributions to the intra-field distortion.

17. A method of determining x-tilt and y-tilt Zernike coefficients in a projection imaging tool, the method comprising:

exposing a reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least one array of alignment attributes;

exposing the reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position is shifted in a desired direction by a desired amount, wherein an alignment attribute exposed during the first exposure and an alignment attribute exposed during the second exposure form a completed alignment attribute;

measuring positional offsets of the alignment attributes in the completed alignment attribute;

determining a lens distortion map from the resulting positional offset; and

determining the x-tilt and y-tilt Zernike coefficients from the lens distortion map.

18. A method as defined in Claim 17, wherein determining the x-tilt and y-tilt Zernike coefficients further includes determining higher order contributions to the intra-field distortion.

19. A method of determining intra-field distortion in a projection imaging tool, the method comprising:

exposing a reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least one array of alignment attributes;

exposing the reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position is shifted in a first desired direction by a first desired amount;

exposing the reticle pattern onto the substrate in a third position, wherein the reticle pattern in the third position is shifted in a second desired direction by a second desired amount, wherein a completed alignment attribute is formed by an alignment attribute exposed during the first position exposure and an alignment attribute exposed during the second position exposure and an alignment attribute exposed during the third position exposure;

measuring positional offsets of the alignment attributes in the completed alignment attribute; and

determining a lens distortion map from the resulting positional offset.

20. A method as defined in Claim 19, wherein the alignment attributes comprise wafer alignment marks.

21. A method as defined in Claim 20, wherein measuring of the positional offsets is performed by a lithography tool wafer alignment mark measurement system.

22. A method as defined in Claim 19, wherein the first and second desired directions are orthogonal to each other.

23. A method as defined in Claim 19, wherein the first direction corresponds to an X direction.

24. A method as defined in Claim 19, wherein the second direction corresponds to a Y direction.

25. A method as defined in Claim 19, wherein the first desired distance equals the second desired distance.

26. A method as defined in Claim 19, wherein the first desired distance is different than the second desired distance.

27. A method as defined in Claim 19, wherein the at least one array of alignment attributes further comprises a first and a second array of alignment attributes wherein the first and second arrays of alignment attributes have features complementary to each other and the arrays have the same pitch and are offset from each other.

28. A method as defined in Claim 19, wherein the reticle pattern in the second position is shifted in a desired direction by an amount so that the second exposure of the array of alignment attributes overlays the first exposure of array of alignment attributes and the reticle pattern in the third position is shifted in a desired direction by an amount so that the third exposure of the array of alignment attributes overlays the first and second exposures thereby forming a completed alignment attribute.

29. A method as defined in Claim 19, wherein the reticle pattern in the second position is shifted in a desired direction by an amount so that the second exposure of the array of alignment attributes overlays the first exposure of array of alignment attributes and the reticle pattern in the third position is shifted in a desired direction by an amount so that the third exposure of the array of alignment attributes overlays the first exposure thereby forming a completed alignment attribute.

30. A method as defined in Claim 19, wherein the reticle pattern in the second position is shifted in a desired direction by an amount so that the second exposure of the array of alignment attributes overlays the first exposure of array of alignment attributes and the reticle pattern in the third position is shifted in a desired direction by an amount so that the third exposure of the array of alignment attributes overlays the second exposure thereby forming a completed alignment attribute.

31. A method as defined in Claim 19, wherein the reticle pattern is a curved field.

32. A method as defined in Claim 19, wherein the an x-tilt and a y-tilt Zernike coefficients of the projection imaging system are determined.

33. A method as defined in Claim 15, wherein determining the x-tilt and y-tilt Zernike coefficients further includes determining higher order contributions to the intra-field distortion.

34. A method of determining x-tilt and y-tilt Zernike coefficients in a projection imaging tool, the method comprising:

exposing a reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least one array of alignment attributes;

exposing the reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position is shifted in a first desired direction by a first desired amount;

exposing the reticle pattern onto the substrate in a third position, wherein the reticle pattern in the third position is shifted in a second desired direction by a second desired amount, wherein a completed alignment attribute is formed by an alignment attribute exposed during the first position exposure and an alignment attribute exposed during the second position exposure and an alignment attribute exposed during the third position exposure;

measuring positional offsets of the alignment attributes in the completed alignment attribute;

determining a lens distortion map from the resulting positional offset; and

determining the x-tilt and a y-tilt Zernike coefficients of the projection imaging system from the lens distortion map.

35. A method as defined in Claim 34, wherein determining the x-tilt and y-tilt Zernike coefficients further includes determining higher order contributions to the intra-field distortion.

36. A method of determining intra-field distortion in a projection imaging tool, the method comprising:

exposing a reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least one array of alignment attributes;

exposing the reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position is shifted in a first desired direction by a first desired amount;

exposing the reticle pattern onto the substrate in a third position, wherein the reticle pattern in the third position is shifted in a second desired direction by a second desired amount;

exposing the reticle pattern onto the substrate in a fourth position, wherein the reticle pattern in the fourth position is shifted in a third desired direction by a third desired amount, wherein a completed alignment attribute is formed by an alignment attribute exposed during the first exposure and an alignment attribute exposed during the second exposure and an alignment attribute exposed during the third exposure and an alignment mark exposed during the fourth exposure;

measuring positional offsets of the alignment attributes in the completed alignment attribute; and

determining a lens distortion map from the resulting positional offset.

37. A method as defined in Claim 36, wherein the alignment attributes comprise wafer alignment marks.

38. A method as defined in Claim 37, wherein measuring of the positional offsets is performed by a lithography tool wafer alignment mark measurement system.

39. A method as defined in Claim 36, wherein the first and second desired directions are orthogonal.

40. A method as defined in Claim 36, wherein the first direction corresponds to an X direction.

41. A method as defined in Claim 36, wherein the second direction corresponds to a Y direction.

42. A method as defined in Claim 36, wherein the third direction corresponds to a rotation.

43. A method as defined in Claim 36, wherein the first desired distance equals the second desired distance.

44. A method as defined in Claim 36, wherein the first desired distance is different than the second desired distance.

45. A method of determining intra-field distortion in a projection imaging tool, the method comprising:

providing an illumination source with a curved projection field;

exposing a curved field reticle pattern onto a substrate with a recording media in a first position, wherein the reticle pattern includes at least two arrays of alignment attributes, the arrays of alignment attributes having features complementary to each other and the arrays have the same pitch and are offset from each other;

exposing the curved field reticle pattern onto the substrate in a second position, wherein the reticle pattern in the second position overlaps the reticle pattern in the first position and is shifted in a desired direction an amount that corresponds to the offset;

measuring positional offsets of the alignment attributes; and

determining a lens distortion map from the resulting positional offset.

46. A method as defined in Claim 45, wherein the complementary features of the at least two arrays of alignment attributes form a box-in-box attribute.

47. A method as defined in Claim 45, wherein the complementary features of the at least two arrays of alignment attributes form a frame-in-frame attribute.

48. A method as defined in Claim 45, wherein the complementary features of the at least two arrays of alignment attributes comprise gratings.

49. A method as defined in Claim 45, wherein the at least two arrays of alignment attributes comprise wafer alignment marks.

50. A method as defined in Claim 49, wherein measuring of the positional offsets is performed by a lithography tool wafer alignment mark measurement system.

51. A method as defined in Claim 45, wherein the at least two arrays of alignment attributes comprise Van der Pauw resistors.

52. A method as defined in Claim 45, wherein the at least two arrays of alignment attributes comprise vernier pairs.

53. A method as defined in Claim 45, wherein the at least two arrays of alignment attributes comprise capacitor structures.